

WHAT IS CLAIMED IS

1. A fat removing device comprising:

a cannula having a longitudinal axis, a proximal end, a distal end, a lumen extending proximally along said longitudinal axis, and an opening in said cannula at said distal end which fluidly communicates said lumen with the exterior of said cannula;

5 a protective mesh attached to said distal end and distal of said opening, said mesh including openings sized to permit human fat cells to extrude through said openings when said mesh is pressed against a mass of human fatty tissue, said openings also sized to prevent a human nerve which underlies said human fatty tissue from passing through said openings when said mesh is pressed against said mass of human fatty tissue.

10 2. A fat removing device in accordance with Claim 1, further comprising an ultrasonic energy transducer positioned adjacent said distal end which operates at a frequency and magnitude which at least partially disrupts the cell walls of said human fat cells.

15 3. A fat removing device in accordance with Claim 1, further comprising a heater positioned adjacent said distal end which heats said human fat cells when said heater is energized to deliver heat

20 4. A fat removing device in accordance with Claim 3, wherein said heater is positioned a distance from said mesh and capable of delivering heat energy to said human fat cells to cauterize a capillary bed in said mass of human fatty tissue when energized to deliver heat.

25 5. A fat removing device in accordance with Claim 1, wherein said cannula is rigid.

6. A fat removing device in accordance with Claim 1, wherein said protective mesh is dome-shaped.

7. A fat removing device in accordance with Claim 6, wherein said dome-shaped protective mesh comprises a plurality of passages therethrough, and a distalmost bearing portion which does not include any passages.

5 8. A fat removing device in accordance with Claim 1, further comprising:  
a cutting element in the cannula, wherein said protective mesh has a shape, and said cutting element has substantially the same shape and is spaced from said protective screen.

10 9. A fat removing device in accordance with Claim 1, wherein said cannula is an outer cannula, and further comprising an inner cannula positioned in said outer cannula, said inner cannula being rotatable in said outer cannula, said inner cannula including a cutting element positioned adjacent and proximal to said protective mesh, whereby when said inner cannula is rotated, and said device is pressed against human fatty tissue to  
15 extrude fatty tissue through said openings, said cutting element cuts off said extruded fatty tissue proximal of said protective mesh.

10. A fat removing device in accordance with Claim 9, wherein said inner cannula comprises a blade formed by the removal of a portion of said inner cannula.

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11. A fat removing device in accordance with Claim 9, further comprising an annular lumen extending between said inner cannula and said outer cannula.

12. A fat removing device in accordance with Claim 9, wherein said inner cannula  
25 comprises a distal end and a lumen extending proximally from said distal end.

13. A fat removing device comprising:  
a cannula having a longitudinal axis, a proximal end, a distal end, a lumen extending proximally along said longitudinal axis, and an opening in said cannula at said  
30 distal end which fluidly communicates said lumen with the exterior of said cannula; and

an energy transmitting wire located in said cannula and including a tip distal of said cannula distal end, said wire and tip being longitudinally movable at a frequency and magnitude which at least partially disrupts the cell walls of said human fat cells.

5     14.     A fat removing device in accordance with Claim 13, further comprising an energy transducer connected to said energy transmitting wire selected from the group consisting of an ultrasonic energy transducer and an RF energy transducer.

10     15.     A fat removing device in accordance with Claim 13, further comprising a bushing in said cannula, said energy transmitting wire passing through and being laterally restrained by said bushing, wherein said bushing causes lateral displacement of said energy transmitting wire proximal of said bushing to cause longitudinal displacement of said energy transmitting wire distal of said bushing.

15     16.     A fat removing device in accordance with Claim 13, further comprising an aspiration port in said cannula distal end, and an aspiration conduit extending distally through said cannula to said aspiration port.

20     17.     A fat removing device comprising:  
a cannula having a longitudinal axis, a proximal end, a distal end, an outer diameter R, a lumen extending proximally along said longitudinal axis, and an opening in said cannula at said distal end which fluidly communicates said lumen with the exterior of said cannula; and

25     a cutting element in said lumen adjacent said cannula distal end, said cutting element spaced from said cannula distal end a distance D;

30     wherein R and D are together selected to permit human fat cells to extrude into said cannula opening when said cannula distal end is pressed against a mass of human fatty tissue, R and D are together selected also being sized to prevent a human nerve which underlies said human fatty tissue from passing into said cannula opening when said cannula distal end is pressed against said mass of human fatty tissue.

18. A fat removing device in accordance with Claim 17, wherein said cutting element comprises a rotatable shaft having a distal end and extending toward said cannula distal end, and at least one radial blade attached to said shaft distal end spaced from said cannula distal end said distance D.

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19. A fat removing device in accordance with Claim 18, wherein said at least one blade is formed of a material which allows said at least one radial blade to be energized as an electrocautery tool.

10 20. A fat removing device in accordance with Claim 18, wherein said at least one blade is angled proximally so that fatty tissue cells which are cut by said at least one blade are pushed proximally when said at least one blade is rotated with said rotatable shaft.

15 21. A fat removing device in accordance with Claim 17, further comprising an irrigation lumen extending distally along said cannula.

22. A fat removing device in accordance with Claim 21, wherein said irrigation lumen is mounted on the exterior of said cannula.

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23. A fat removing device in accordance with Claim 17, wherein the ratio D/R is approximately 1.0.

24. A fat removing device comprising:

25 a cannula having a longitudinal axis, a proximal end, a distal end, a tip at said distal end, a lumen extending proximally along said longitudinal axis, and an opening in said cannula at said distal end which fluidly communicates said lumen with the exterior of said cannula;

said cannula tip being angled inward; and

30 a cutting element in said lumen adjacent said cannula distal end;

wherein said cannula tip angle is selected to permit human fat cells to extrude into said cannula opening when said cannula distal end is pressed against a mass of human

fatty tissue, said cannula tip angle also being selected to prevent a human nerve which underlies said human fatty tissue from passing into said cannula opening when said cannula distal end is pressed against said mass of human fatty tissue.

5     25.     A fat removing device in accordance with Claim 24, further comprising at least one heater formed in said cannula tip which heat said fatty tissue when energy is supplied to said at least one heater.

26.     A fat removing device comprising:

10             a cannula having a longitudinal axis, a proximal end, a distal end, a closed tip at said distal end, a lumen extending proximally along said longitudinal axis, and an opening in said cannula proximal of said distal end which fluidly communicates said lumen with the exterior of said cannula;

           a rotatable shaft in said cannula;

15             a blade attached to said rotatable shaft adjacent said opening;

           wherein when said cannula opening is pressed against a mass of human fatty tissue, and when said rotatable shaft is caused to rotate, said blade rotates and cuts fatty tissue which has extruded through said opening, said cannula opening being sized to prevent a human nerve which underlies said human fatty tissue from passing into said  
20     cannula opening when pressed against said mass of human fatty tissue.

27.     A fat removing device in accordance with Claim 26, wherein said blade is mounted to said rotatable shaft offset from an axis of rotation of said rotatable shaft.

25     28.     A fat removing device in accordance with Claim 26, wherein said blade is cup-shaped.

29.     A fat removing device in accordance with Claim 26, further comprising a nerve guard mounted on an exterior surface of said cannular immediately adjacent to said  
30     opening.

30. A fat removing device in accordance with Claim 29, wherein said nerve guard comprises a thin member which extends from a point distal of said opening to a point proximal of said opening and extends across said opening.

5 31. A fat removing device in accordance with Claim 30, wherein said thin member is a first thin member, and said nerve guard comprises a second thin member which extends across said first thin member.

10 32. A fat removing device in accordance with Claim 26, wherein said blade is formed of a material which allows said at least one blade to be energized as an electrocautery tool.

15 33. A fat removing device in accordance with Claim 26, wherein said rotatable shaft has an axis of rotation, said blade includes a distal tip and a proximal end, said blade angling relative to said axis of rotation from said distal tip to said proximal end, said blade being curved in a direction substantially perpendicular to said axis of rotation so that said blade acts as an auger when rotated about said axis of rotation.

20 34. A fat removing device in accordance with Claim 26, further comprising at least one ring electrode on the exterior of said cannula, wherein said at least one ring electrode and said blade together form two poles of a bipolar electrocautery circuit.

25 35. A fat removing device in accordance with Claim 26, wherein said blade is formed of at least three layers, including a top layer formed of an electrically conductive material, a bottom layer formed of an electrically conductive material, and a middle layer formed of an electrically insulative material, wherein when said top layer and said bottom layer are connected to opposite poles of an electrocauterizing device, said blade is a bipolar electrocauterizer.

30 36. A fat removing device in accordance with Claim 26, further comprising at least one RF electrode protruding from the exterior of said cannula adjacent to said opening.

37. A fat removing device in accordance with Claim 36, wherein said at least one RF electrode comprises two RF electrodes protruding from said cannula on opposite sides of said opening.

5 38. A fat removing device in accordance with Claim 36, wherein said at least one RF electrode comprises four RF electrodes.

39. A fat removing device in accordance with Claim 26, further comprising at least one fluid nozzle adjacent said opening and directed toward said opening, and a high  
10 pressure fluid lumen in fluid communication with said at least one nozzle, wherein when said cannula is pressed against fatty tissue and fatty tissue is thereby caused to extrude into said opening, and high pressure fluid is caused to flow through said high pressure fluid lumen and out said at least one nozzle, said high pressure fluid cuts said fatty tissue.

15 40. A fat removing device in accordance with Claim 39, wherein said at least one fluid nozzle comprises two fluid nozzles.

41. A fat removal tool for removing fat while protecting nerves, comprising:  
a screen having at least one passageway sized to allow fat cells to extrude through  
20 the screen while preventing a nerve from passing through said screen;  
a separate cutting member positionable adjacent to said screen to cut fat which has been extruded through said screen passageway.

42. A fat removal tool in accordance with Claim 41, wherein said at least one  
25 passageway comprises a plurality of passageways arranged in a regular array.

43. A fat removal tool in accordance with Claim 41, wherein said screen includes a substantially rectangular plate in which said at least one passageway is formed.

30 44. A fat removal tool in accordance with Claim 41, further comprising a handle attached to said screen.

45. A fat removal tool for removing fat while protecting nerves, comprising:  
a handle having a proximal end, a distal end, and a hollow interior;  
a screen at said handle distal end, said screen including at least one passage  
therethrough, the at least one passage being dimensioned to allow fat cells to extrude  
5 through while preventing nerves from passing therethrough;  
a rotatable blade in said handle and immediately proximal of said screen; and  
a rotatable shaft attached to said blade and extending proximally from said  
rotatable blade.

10 46. A fat removal tool in accordance with Claim 45, wherein said screen is circular  
and flat.

47. A fat removal tool in accordance with Claim 45, further comprising a source of  
suction in fluid communication with said hollow interior, a source of irrigation fluid in  
15 fluid communication with said hollow interior, and a source of electric power in electrical  
communication with said rotatable blade.

48. A fat removal tool in accordance with Claim 47, said handle further comprising a  
suction control switch which controls fluid flow to said source of suction, an irrigation  
20 control switch which controls fluid flow to said hollow interior, and a power control  
switch which controls current flow to said rotatable blade.

49. A fat removal tool for removing fat while protecting nerves, comprising:  
a screen having at least one passageway sized to allow fat cells to extrude through  
25 the screen while preventing a nerve from passing through said screen;  
a cutting member adjacent to said screen and movable over said screen to cut fat  
which has been extruded through said screen passageway.

50. A fat removal tool in accordance with Claim 49, further comprising a handle, and  
30 an extension connected between said handle and said screen.



51. A fat removal tool in accordance with Claim 50, further comprising an actuator connected to said cutting member and extending proximally from said cutting member to said handle, said actuator being movable along said handle, wherein movement of said actuator along said handle moves said cutting member over said screen to cut fat which  
5 has been extruded through said screen passageway.

52. A fat removal tool in accordance with Claim 51, wherein said actuator includes electrically conductive portions in electrical communication with said cutting member, and said cutting member is formed of a material which allows said cutting member to be  
10 energized as an electrocautery tool.

53. A fat removal tool in accordance with Claim 49, wherein said screen comprises a substantially rectangular plate in which said at least one passageway is formed, a peripheral upstanding lip, and a sidewall extending between said lip and said plate.  
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54. A fat removal tool in accordance with Claim 53, further comprising two slots formed in said sidewall, said cutting member having two ends slidably located in said slots, wherein when said actuator is moved along said handle, said actuator slides said cutting member in said slots and over said screen to cut fat which has been extruded  
20 through said screen passageway.

55. A method of removing fatty tissue while protecting nerves, comprising the steps:  
exposing a portion of said fatty tissue;  
pressing said fatty tissue with a surface having at least one hole;  
25 extruding fat through said at least one hole, the hole being dimensioned to allow fat cells to extrude through while preventing nerves from passing therethrough; and  
cutting said fat that has extruded through said hole on a side of said surface opposite said fatty tissue.

30 56. A method in accordance with Claim 55, wherein said step of extruding fat further comprises the step of preventing nerves from passing through said at least one hole.

57. A method in accordance with Claim 55, wherein said step of cutting said fat further comprises cutting said fat with an electrocautery cutting element.

58. A method in accordance with Claim 55, further comprising heating said fatty  
5 tissue at a time selected from the group consisting of prior to said cutting step, during said cutting step, and both prior and during said cutting step.

59. A method in accordance with Claim 55, wherein said step of pressing said fat layer further comprises pressing with a surface having at least one hole located on a  
10 distalmost end of a cannula.

60. A method in accordance with Claim 55, wherein said step of pressing said fat layer further comprises pressing with a surface having at least one hole located proximal of a distalmost end of a cannula.

15 61. A method of removing fatty tissue while protecting nerves, comprising the steps:  
exposing a portion of said fatty tissue;  
pressing said fatty tissue with a surface which vibrates at a frequency and  
magnitude sufficient to rupture cell walls contained in said fatty tissue; and  
20 aspirating fatty tissue.

62. A fat removal tool comprising:  
two bipolar wires each having a cross-sectional diameter and a centerline, each  
bipolar wire having a cross-sectional diameter from about 0.150 inches to about 0.045  
inches, the two bipolar wires spaced from each other at a centerline-to-centerline distance  
25 from about 0.040 inches to about 0.200 inches.

63. A fat removal tool in accordance with Claim 62, further comprising a separate shield to protect major arteries or veins positioned adjacent to the two bipolar wires.

64. A fat removal tool in accordance with Claim 62, further comprising a sheath having holes through which fat can protrude when the distal tip is placed in fat.

65. A fat removal tool in accordance with Claim 62, wherein the two bipolar wires each have a cross-section diameter of 0.031 inches.

5 66. A fat removal tool in accordance with Claim 62, wherein the two bipolar wires each have a centerline-to-centerline distance of about 0.080 inches.

67. A fat removal tool comprising:

a first outer sheath electrode having a lumen and a distal end, the outer sheath electrode including holes at the distal end to allow fat to enter the lumen;

10 a second helical wireform inner rotatable electrode positioned in the lumen to rotate relative to the holes to move to the proximal end of the tool any fat that is melted upon application of radio frequency energy between the first and second electrodes. such that a vacuum source can remove the fat from the tool.

68. A fat removal tool in accordance with Claim 67, wherein the holes in the distal end of the first electrode have a diameter from 10% less than the diameter of the nerve to  
15 be protected to 6 mm.

69. A fat removal tool in accordance with Claim 67, wherein the holes in the distal end of the first electrode have a diameter 10% less than the diameter of the nerve to be protected.  
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70. A fat removal tool in accordance with Claim 67, wherein the holes in the distal end of the first electrode have a centerline-to-centerline spacing from the diameter of the nerve to be protected to 6 mm.

25 71. A fat removal tool in accordance with Claim 67, wherein the holes in the distal end of the first electrode have a centerline-to-centerline spacing of about the diameter of the nerve to be protected.

72. A fat removal tool in accordance with Claim 67, wherein the absolute distal end of the first electrode has no hole on the centerline of the first electrode.

73. A fat removal tool in accordance with Claim 67, wherein the second helical  
5 wireform rotating electrode is formed of wire of between about 0.015 inches and about 0.045 inches in diameter.

74. A fat removal tool in accordance with Claim 67, wherein the second helical wireform rotating electrode is formed of wire of about 0.031 inches in diameter.

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75. A fat removal tool in accordance with Claim 67, wherein the first electrode has an inner diameter and the second electrode is spaced from the first electrode inner diameter a distance between about 0.005 inches and about 0.170 inches.

15 76. A fat removal tool in accordance with Claim 67, wherein the first electrode has an inner diameter and the second electrode is spaced from the first electrode inner diameter a distance of about 0.020 inches.

77. A fat removal tool in accordance with Claim 67, further comprising:  
means for rotating the second electrode in the lumen relative to the first electrode.

78. The fat removal device of claim 1, wherein the openings in the mesh are between 10% less than the diameter of the nerve to be protected to 6 mm.

79. The fat removal device of claim 26, wherein the cannula opening is between a diameter from 10% less than the diameter of the nerve to be protected to 6 mm.

80. The fat removal tool of claim 41, wherein the passageway in the screen is between a distance 10% less than the diameter of the nerve to be protected to 6 mm.

81. The fat removal device of claim 45, wherein the at least one passageway in the screen is between a distance 10% less than the diameter of the nerve to be protected to 6 mm.

82. The fat removal device of claim 55, wherein the hole is dimensioned with a diameter from 10% less than the diameter of the nerve to be protected to 6 mm

83. The fat removal device of claim 3, wherein the protective mesh thermally insulates the nerve from the heater.

84. The fat removal device of claim 83, wherein the protective mesh is made of a polycarbonate material.

85. The fat removal device of claim 83, wherein the protective mesh is made of a polyfluorinated material.

86. The fat removal tool of claim 41, wherein the screen thermally insulates the nerve from the heater.

87. The fat removal tool of claim 86, wherein the screen is made of a polycarbonate material.

88. The fat removal device of claim 86, wherein the screen is made of a polyfluorinated material.

89. The fat removal tool of claim 49, wherein the screen thermally insulates the nerve from the heater.

90. The fat removal tool of claim 89, wherein the screen is made of a polycarbonate material.

91. The fat removal device of claim 89, wherein the screen is made of a polyfluorinated material.